Aligning supply chain collaboration using Analytic Hierarchy Process

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The significance of collaboration among supply chain members has been sufficiently stressed in the recent literature as a powerful tool for increasing accuracy of demand forecasts and for consequent cost reductions. Since it has been recognized that naïve forecasting is no longer cost efficient, Supply Chain (SC) members have found it very important to exchange relevant information that will help improve accuracy of demand forecasting. This information differs widely in terms of their characteristics. For example, some information (e.g. historic sales data) that is cheap to exchange may not contribute to a great increase in forecast accuracy. Similarly, some information may not be very reliable (e.g. demand forecast by individual SC members). In general, there is a trade-off in the kind of information required and the kind of information exchanged. This study analyses these trade-offs using an Analytic Hierarchy Process (AHP) model. The model is then implemented based on case studies conducted in two manufacturing firms. The AHP model ranks available information in terms of their contributions to improve forecast accuracy, and can provide vital clues to SC partners for preparing exchangeable data. From the case studies using AHP model, it was proved that using the preferred SC data, the firms could enhance forecasts accuracy. This in turn can help the firms to make decisions on SC collaborative arrangements for information exchange.

1. Introduction

In the past two decades, supply chain management has been recognized as a powerful business tool to survive in the competitive marketplace. Supply Chain (SC) operators have started considering the changing interests of consumers and their shifting loyalty whilst managing supply chain inventory, capacity and production, and delivery management. This is reflected in collaborative relationships between SC partners to avoid stock-outs and excess inventory [22,6]. Several collaborative SC tools such as Vendor Managed Inventory (VMI) and Collaborative Planning Forecasting and Replenishment (CPFR) are being increasingly adopted by SC operators to improve SC efficiency.

Some manufacturers practicing Supply Chain Collaboration (SCC) and advanced information integration with retailers have realised cost reduction and increased revenue [25]. Many researchers have discussed the role of supply chain information and quality of information in improving supply chain performance [18,19]. Information Sharing (IS) among partners facilitates flow of goods in the supply chain [6] and also helps to forecast demand more efficiently. However, the benefits of IS are highly dependent on the context and proper use of available

information [34]. Forecast information quality may be lower for upstream members in the supply chain, especially for manufacture-to-order suppliers [18], but effective and efficient handling of available data will enhance the performance of supply chain and yield more benefits [23].

All available information may not be equally useful for the purpose of forecasting or decision making for all SC partners [27,34]. For instance, demand or transaction information may be more important to retailers than manufacturers, while product or inventory information may be more important to the latter. Yu et al. [48] showed that centralized IS benefits manufacturers more than retailers. They also suggested some incentives to retailers in order to encourage their participation in information sharing. Ovalle and Marquez [33] classified information into three types: product information, customer demand and transaction information, and inventory information. This classification varies widely depending on the firms involved in SCC. An exceptional level of service can be achieved through integrated information [24]. Although the benefit of IS is not necessarily the same to all SC members, it is perceived as one of the critical success factors for collaborative supply chains [22]. This paper refers to the information exchange among members of SC collaboration as 'Collaborative Information Exchange' (CIE), and it is discussed with regard to improving demand forecasts.

In contrast to the above literature, Småros [42] identified from case studies that manufacturers' initiative on establishing collaboration for IS and forecasting with downstream members such

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as retailers wholesalers and distributors is an uncommon practice. However, there is no systematic approach in the existing literature for identifying importance of IS under SC collaboration. This paper, through two exploratory case studies, tries to study and rank the information needs of manufacturing firms to improve forecast accuracy. This paper has two objectives:

- To identify and prioritize the information need in CIE to attain forecast accuracy. As mentioned earlier, various kinds of SC information have differing levels of importance to SC operators. This study attempts to develop a new AHP-based framework to arrive at the relative importance of this information by eliciting opinions from SC operators.
- To decide the level of collaboration in SC. Depending on the importance of information, some SCs may have to engage in very close collaboration, while some SCs may not need very close engagement. A framework is established to decide on the levels of collaboration using the AHP model.

The rest of the paper is organized as follows. The literature on evolution of information exchange in SCC is discussed briefly in Section 2. Research methodology is detailed in Section 3. Two case studies are briefly discussed in Section 4. Based on the case study observations, an AHP model is developed and analyzed in Section 5. The findings of AHP analysis are discussed in Section 6. The final section concludes with the research observations. This section also discusses scope for future work.

2. Evolution of collaborative information exchange (CIE)

In contrast to conservative SC practices, today's SC management is more transparent to SC operators. Healthy collaborative arrangements among SC partners are proving to be successful in many world-class businesses such as Wal-Mart, Sara Lee, Nabisco etc. [28]. In order to improve SC processes and to gain collaborative support from the other SC partners, several SC management practices such as VMI, Efficient Consumer Response, Continuous Replenishment, and Electronic Data Interchange have been suggested in the literature. In an attempt to introduce readers to the concept of information exchange in SC collaboration, two of the famous SC tools are briefly discussed (VMI and CPFR) below.

In VMI (developed in the mid 1980s), the customer's inventory and replenishment process are managed by manufacturer or supplier. However, SC visibility has not been found to be totally immune to the bullwhip effect [4]. This may be due to the fact that the information exchange is not highlighted much in VMI, except for inventory information [40]. Noran [32] proposed a decision framework with a step-by-step approach, incorporating knowledge of various elements of the organization. However, Noran did not discuss the role of information within the concept of collaborative network.

Ever-increasing SC demands have led to the invention of CPFR, another SC management tool, which incorporates planning, forecasting and replenishment under a single framework [17]. In recent literature, the benefits of SC collaboration and IS have been exposed through case studies conducted in European companies [42,13]. By obtaining demand information from downstream members, manufacturers can reduce SC costs [34]. Knowledge of demand information can reduce the inventory cost of both suppliers and customers [19,27,12,9] and help planning future business plans and promotions [37]. Sharing demand information along with inventory status among SC partners can help achieve elevated reduction in inventory cost and obsolescence [6,31].

In CPFR, demand forecast is a collective effort of all of the participating members of SC. A mathematical model developed by

Aviv [2] captured the benefit of sharing local forecasts, particularly for products of shorter lead time. Depending on forecasting capabilities, the benefits of IS range from basic inventory reduction to higher profit earnings. In certain cases, readily available historical order data can reduce variance in demand forecast if it is used efficiently [34]. Knowledge of recent Point-Of-Sale data (POS) can improve forecast of promotions and new products [42]. POS data- and market data-sharing were found to be influential in achieving forecast accuracy in an augmented CPFR model developed by Chang et al. [10]. More detailed literature on the value of information sharing in SC was discussed by Li et al. [29]. In recent literature, Cao and Zhang [8] considered impact of SCC in company performance; While, Ramanathan et al. [35] discussed various performance metrics for evaluating collaborative SCs.

Although CPFR has been considered to be a better SC tool than VMI [40], recognizing the type of IS among SC members in order to build more visibility is a big challenge [4]. Ryu et al. [38] evaluated demand information sharing methods in supply chains. Almost all of the articles in the literature have concentrated on particular SC information, such as inventory or sales, but have not considered all of the available information. In this paper, the information need in CIE is identified and ranked through appropriate case studies.

Two exploratory case studies were conducted in manufacturing firms to examine the nature of CIE practices. In this exploratory study, an attempt was made to identify the type of information used in improving forecast accuracy under manufacturer-initiated SC collaboration. The two firms differed in terms of their capabilities (technical/communication and forecasting) to contribute to CIE. The first firm had high levels of technical capabilities to enable CPFR implementation but chose to work on pilot projects on CIE for the past two years. The other company was interested in CIE but had no immediate plans for a collaborative SC program such as CPFR. However, both companies have been employing demand forecasts as the basis for their long- and short-term planning. By analyzing these two firms for collaborative information exchange, the importance of different varieties of supply chain information for improved demand forecast accuracy was identified and ranked. The approach of the present paper includes two case studies and the AHP technique, explained in the next section.

3. Research methodology

A case study approach was adopted as this is an ideal methodology when exploratory in-depth understanding is needed [45]. Using our initial interactions with relevant officials of the case companies, we first identified various factors influencing their decisions to participate in CIE. We then obtained the opinions on the performance of the companies in terms of the identified factors using semi-structured interviews with four high level officials of these companies. We used these opinions in the implementation of the AHP model [21,3].

The case study approach was organized in two phases:

i) In the first phase, an attempt was made to explore the current collaboration practices (particular to CIE) of the case company with other SC partners. The author visited the case companies personally to better understand their relationship with other SC members. The emphasis in this phase was more on understanding the information used by the firms to create their demand forecast.

ii) In the second phase, interviews were conducted with a view to developing a structured procedure to facilitate a deeper understanding of the informational requirements for CIE. The case